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A thoroid γ-counter with high solid angle for coincidence spectrometry

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With 3 figures in the text

A good deal of work has recently been made in order to increase the efficiency of γ-counting devices. As is well known, the most important improvement in this field was the introduction of the scintillation counter technique. In spite of the high absolute efficiency of this method there still seems to be wide applications for the more conventional G. M. counter technique. For instance, when performing well reproducable $\beta\gamma$- and $\gamma\gamma$-coincidence measurements, when the arrangement has to be accurately calibrated once and for all with regard to the γ-efficiency as a function of the γ-energy, the ordinary scintillation counter technique so far has met with some difficulties, and thus has not yet been able to replace the G. M. counter technique, which on its hand has been found easy to standardize.

The efficiency of a G. M. tube may be increased in mainly three different ways. One can increase the solid angle subtended by the tube relative to the source, or one can design the counter in such a way as to increase the amount of γ-absorbing material, or finally one can use a cathode material of high γ-value to increase the number of photo electrons.

In the present paper we are dealing with the case of trying to increase the solid angle of the γ-tube, when this is situated in the magnetic field in a spectrometer. If an ordinary counter is placed immediately behind the sample, we may have a solid angle of nearly 2π. This arrangement would however introduce a very pronounced distortion of the β-spectrum because of back scattering from the counter wall. A $\beta\gamma$-coincidence spectrum obtained in this way, should be widely different from the true form. If on the other hand the γ-counter is placed on a safe distance from the β-source in order to get an undisturbed form of the spectrum, the number of coincidences goes down.

We have solved this problem by surrounding the source by one single thoroid shaped counter. The mounting can be seen in Fig. 1. The thoroid counter is mounted directly on the removable pole shoe of the high transmission intermediate image spectrometer.[1] The sample is then easily introduced through the vacuum lock device to its correct position at the center of the thoroid tube. The tube is sealed off and calibrated for efficiency as a function of γ-energy.

This mounting will give no noticeable distortion of the spectrum in spite of the fact that the solid angle is as much as 50 % of the total sphere. Furthermore the

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[1] H. SLÄTIS and K. SIEGBAHN, Ark. f. Fysik, *1*, 339, 1949.

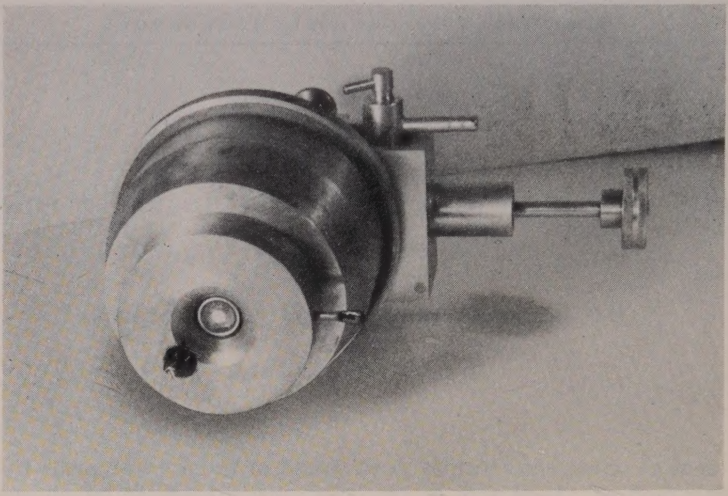

Fig. 1. Photo of the thoroid γ-counter mounted on the spectrometer pole shoe. The vacuum lock device is seen on the back of the pole shoe. The sample is in standard position in the middle of the thoroid counter.

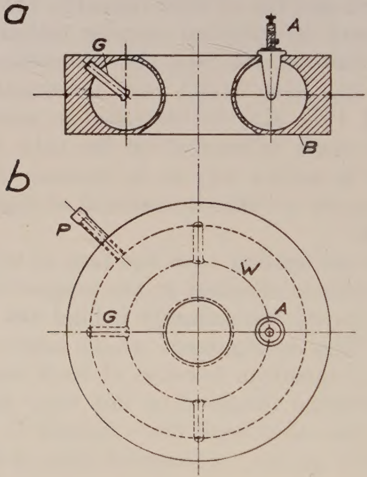

Fig. 2. Sections of the thoroid counter.

solid angle is very insensitive to small changes in the position of the sample and also to the size of the sample.

Fig. 2 shows the two sections of the thoroid counter. It is made up of two halves, which are soldered together, after the anode wire has been mounted. The anode wire ($\varnothing = 0.3$ mm) consists of a loop, suspended on four pyrex glass rods. One of these goes through the wall of the tube and contains the anode electrode. Fig. 3 shows a photo of the two halves before they have been soldered together.

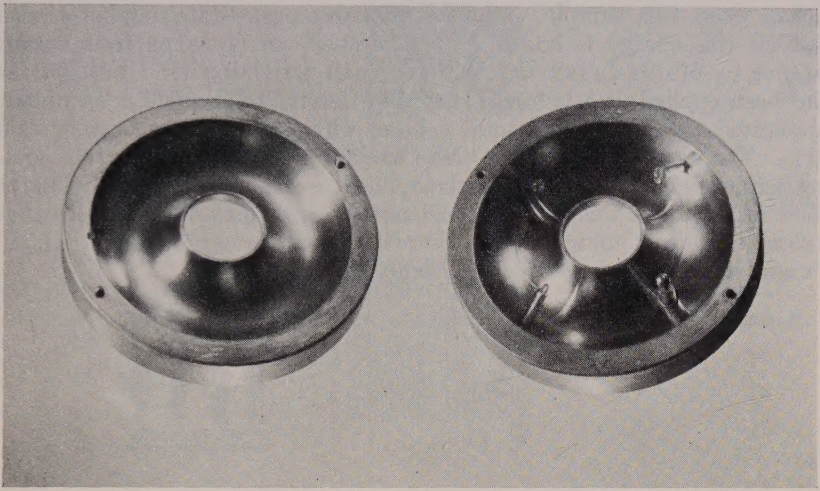

Fig. 3. Thoroid counter before the two halves have been soldered together.

Our first thoroid counter was designed to be used in a β-limegraph.[1] This counter was much bigger and could in some respects almost be considered as consisting of six ordinary tubes after each other. The new γ-tube has a much more compact form, giving an electric field rather different from that in an ordinary counter. All our tests with it shows, however, that it operates in a very satisfactory way. It has a good, stable plateau of about 200 volts, a background of 220 counts a minute and shows no signs of spurious counts.

An ordinary "straight" G. M. counter has a sensitivity, which is constant in the middle of the tube but then decreases continuously towards the ends of the tube because of the change in the electric field. In many experiments (for instance when making activity measurements of gases, introduced in the counter) this decrease in sensitivity is very awkward and hard to correct for. The thoroid counter should behave in a different way since there should be practically no change in the electric field in this case.

In order to check its constant response for γ-radiation in different parts of the tube, a well collimated narrow beam of Co^{60} γ-radiation ($E_\gamma \sim 1.2$ MeV) was allowed to strike the tube. The counter was then rotated and the number of counted quanta plotted as a function of the angle of rotation. In this way it was found that the sensitivity was almost constant, except for small dips in intensity (a few percent) in the neighbourhood of the glass rods.

Next, the total effective solid angle was measured experimentally by putting a Co^{60} sample in the correct position, i.e. at the center of the tube. The number of quanta emitted from this sample had been determined before both by comparing it with a standard sample calibrated at Bureau of Standards and by βγ-coincidence measurements in our own standard set up. The number of quanta emitted from the source obtained from these two measurements checked with each other within 5 %. The effective space angle of the thoroid counter can then be found by registering the

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[1] K. Siegbahn and H. Slätis, Ark. f. Mat. Astr. o. Fysik, *36 A*, 22, 1949.

γ-radiation from this sample, provided the absolute γ-efficiency of the cathode material for this energy is known. This number can be taken from curves given for instance by MAIER-LEIBNITZ.[1] After a small correction for γ-absorption in the wall had been applied, it was found that the effective solid angle determined in this way amounted to 49 % of the total sphere, whereas the geometrically calculated was 50 %. The agreement between these two figures is better than one could hope for considering some of the errors involved, but it seems justified to conclude that the combined results from this measurement and the previous one, indicate that there is practically no dead volume in the thoroid counter, a circumstance, which ought to be useful in many kinds of experiments.

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[1] H. MAIER-LEIBNITZ, Zeits. f. Naturforschung, *1*, 243, 1946.

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